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Study of Projection Welding with degreasing Process on material AISI-1018

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ABSTRACT

Projection welding is a welding which works on the principal of Resistance Welding, in which current flow is concentrated at the point of contact with a local geometric extension of the parts being welded. The extensions or projections are used to concentrate heat generation at the point of contact. Heating is facilitated by resistance heating and is highly influenced by the contact area resulting from the amount of deformation, which is also temperature dependent due to material softening and frictional conditions. This research investigates the principle of projection welding based on the parameters (current and time) on Rod and Housing of stabilizer link assembly which are made up from material AISI 1018. The purpose of this research is to improve the mechanical properties of the material by using the process of degreasing and to study its influence on the joint strength between steel bar and housing. The fatigue, yield and Tensile tests are used to evaluate the joint strength comparable to the joint made from unprocessed mild steel.

Key Words: Projection Welding, Degreasing, Yield Strength, Tensile Strength Fatigue Strength

INTRODUCTION

Resistance welding was discovered by Elihu Thompson after accidentally fusing copper wires during an experiment. Based on his findings he applied for a patent "apparatus for electric welding" in 1885[1] .

The welding process is carried out in three stages.

- In the first step the parts to be welded are clamped with cooled copper electrodes.
- With maintained clamping pressure, the second step involves passing a welding current through the pieces. Resistive heating then melts the interfaces and the formation of a "weld nugget" of the parts which forms a weld.
- Finally the current is stopped and the metal solidifies during a short cooling time under pressure before the clamping force is released in the third step.

Resistance projection welding is a variation on resistance spot welding. Basically, a protrusion is placed on one of the two materials to be welded. This projection is then brought into contact against the second material.

The welding sequence is similar to that for resistance welding. The welding electrodes are used to apply both force and current across the configuration. The point of contact acts to constrict current flow and heating occurs preferentially at this point. As the material heats it becomes soft, and the projection collapses under the force applied by the welding electrodes. Due to the amount of plastic flow involved, melting is not always necessary to form a sound joint.

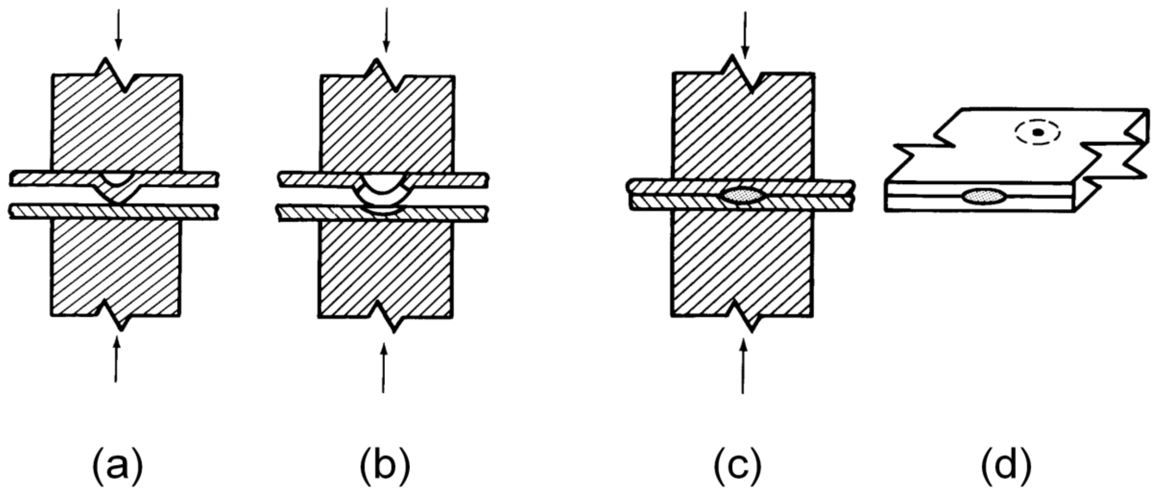

Fig. 1

The sequence of events during the formation of a projection weld is shown in the above this figure, which works on the principal of resistance welding. In Figure (a), the projection is shown in contact with the mating sheet. In Figure (b), the current has started to heat the projection to welding temperature. The electrode force causes the heated projection to collapse rapidly and then fusion takes place as shown in Figure (c). The completed weld is shown in Figure (d)[2].

Degreasing

Degreasing is a process for cleaning products from water-insoluble substances such as grease, fats, waxes, carbon deposits, fluxes and tars. In most cases the process is applied to metal products, but also plastic, fiberglass, printed circuit boards and other products are treated by the same process. The metal-working industries are the major users of solvent degreasing. Solvent degreasing is also used in industries such as printing and production of chemicals, plastics, rubber, textiles, glass, paper, and electric power. According to material's performance AISI 1018 Trichloroethylene is the best solution for degreasing this material

LITERATURE REVIEW

Like other resistance welding processes, many variables or parameters control the quality of a projection weld. Primarily, these parameters include projection design, electrode force, welding current, welding time and the type and thickness of the materials being welded. Some experimental research programs on projection welding were carried out to study the influence of the parameters on the projection mechanism, weld size and weld performance and well as on the height and type of projections used for the welding.

X. Sun [2001] [3] have adopted the finite element analysis procedure which is used as a modeling tool which is used to study the effect of projection design on the projection collapse process and heat generation patterns during the early stage of the projection welding process. Three projection designs were used as a powerful tool to study the detailed process physics of a highly dynamic, coupled process such as projection welding and provide some quantitative understanding and guidelines about projection design and welding parameter selection. It was also found that interfacial contact behavior (contact area change due to projection collapse) played a critical role in the initial heating process in projection welding. The dynamic balance between projection collapse and heat generation must therefore be maintained to optimize the projection welding process.

X. Sun [2000] [4] have determine finite element analysis procedure is presented which is used to simulate the coupled electrical-thermal-mechanical phenomena associated with the projection welding process. Research also predicted Projection collapse and the nugget formation process. She also described the effects of different welding parameters, such as welding current, electrode force and sheet material combination and also used as a predictive tool to optimize the welding parameters for a specific projection design to ensure nugget size and weld quality. Variations of process parameters during welding, such as electrode movements, contact area change and dynamic resistance, has been be monitored during the welding process simulation.

Mircea Burca et. al. [2013] [5] studied the shortcomings in achieving quality welds as compared to thin plates welding <3mm, with applications in welding the parts of the navvy chassis structures. They also present the findings of experimental research on M8 nuts welding technology. Generally In electric weld nuts fixed by resistance welding is used frequently on thin plates. Welding of steel nuts on heavy plates presents some difficulties in term of assuring welding quality as compared to welding on thin plates, due to difficulty of ensuring plate's heating and melting which leads to a poor welding joint from the mechanical strength point of view.

Van Otteren et. al. [2004] [6] relates projection Welding of metal sheet to another metal body and more specifically, to an improved projection and projection forming process for thin aluminum sheet for projection Welding. They formed the projection in different shapes of truncated conical or partial spherical shape and wall thickness of the projection being thinner compared results in the base Wall of the projection, being disposed in a sloped or angled relationship relative to the plane of the sheet. They also studied that when projection welding done on an aluminum sheet, however, totally different melting temperature and tensile strength properties are exhibited by aluminum sheet in comparison to steel sheet with an improved projection associated with a thin aluminum sheet for permitting successful performance of a projection welding operation, without experiencing premature collapse, thereby maintaining proper interface pressure, contact area, and current density between the projection and the adjacent metal body at which the projection rapidly collapses to create a metallurgical bond between the overlapped metal sheets and body.

Valdir Furlanetto et. al. [2012] [7] have adopted a first sight, the ultrasonic system which can easily detect any deviation in the welding process, with some major advantages when compared to their current inspection procedure in which torque tests applied statistically in some locations over the body shop. They also investigated that it will be necessary to run some correlation tests regarding different joint, thickness and nuts in different sizes. In this test determination of correlation from the measured melted area with torque, load tensile and nugget area can provide more accuracy data of process variability, besides their faster response, predicting the process maintenance and also to increase the reliability of the process. A dedicated probe have developed so that to enhance image acquisition.

Hess et. al. [1949] [8,9] have limited their investigations to coined embossed projections with a spherical shape. The latter because those researchers assumed that spherical geometry offered the best possibilities for symmetrical current distribution and uniform projection collapse. Using a strain gage based device attached to the electrodes and coupled to an oscillograph, they measured and recorded electrode displacement during projection collapse. They concluded that projection height/diameter ratio highly influenced weld strength levels over a greater range of welding conditions, They also found that the projection diameter was not very critical within a wide range of values. They determined multiple projection welds did not result in shear or normal tension strengths proportional to single weld

Nippes et. al. [1950] [10] built further on Hess and Childs work. They studied projection welding of steel with low thickness and also investigated steel in heavy gages and projection welding with different thicknes. It was found that the use of spring loaded electrodes to provide low welding pressure for low thickness shell and still gives sufficiently rapid follow up during projection collapse.

Nippes et. al. [1952] [11] have investigated the effects of different welding parameters and projection dimensions on weld formation and weld quality for both thin- and heavy-gauge materials such as AISI 1010 and AISI 1015. Cross-tension and lap-shear tests were conducted to relate the strength of the weld to the different welding parameters. It was also found that a spring loaded electrode was necessary in welding thin-gauge material to provide rapid electrode follow up to prevent unwanted expulsion.

Harris et. al. [1961] [12] studied projection welding of low-carbon steel by cross sectioning the weld nuggets for consecutive weld times. The formation of the projection welds and the effects of welding variables such as welding currents, electrode force and welding time were qualitatively explained. Based on the knowledge accumulated from numerous experimental tryouts, some useful guidance was provided on the selection of welding equipment and process variables for welding low-carbon steels with embossed projections.

Vichniakov et. al. [2002] [13] disseminated the results of their study on projection welding showing large displacements during the follow-up stage in the welding cycle using Ansys commercial code. They concluded that FEM can also in this range of workpieces be used for determination of welding range diagrams.

MATERIAL SELECTION

Mild carbon steel has also wider application in the different types of industries and used in manufacturing of copious amount of spare parts, assemblies and machineries in industries. we have chosen AISI 1018 as base material for welding.

Table 1 Base Metal Designations

BS:970 EN:SPECN	DIN	SAE/AISI SPECN
EN –3A	CK 22	1018

According to the different norms and standards, the base material has identical names and hence shown in Table 4.1. The carbon content of AISI 1018 material can vary from 0.36 % to 0.45 % where as Mangenese 0.60 % to 0.90 %, Silicon 0.15 % to 0.35 %, Sulphur content is limited to 0.055 % maximum and Phosphorus up to maximum limit of 0.055 %

Table. 2 Chemical Composition of Base Metal

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Base Metal	Carbon	Mangenese	Silicon	Sulphur	Phosphorus
AISI 1018 (Actual)	0.44	0.83	0.28	0.031	0.038

Test specimen preparation

The material (AISI 1018) used for this study is a carbon steel's specimens which were then prepared for welding. In stabilizer link Assembly there is a rod and housing which are joined by projection welding. Before welding a projection of 0.6mm (which is slightly tapered) has been formed on the rod specimen by the operation of outer diameter Turning from CNC Lathe machine. After welding, this weld joint (as shown in fig. 4) goes for next operation for the assembly(as shown in fig. 5). The samples of rod having length of 300mm with diameter of 10mm (as shown in fig. 2) and Housing has diameter of 27mm with height of 30mm(as shown in fig. 3). The picture of test samples of a single specimen before performing welding procedure is shown $in.

Fig. 2 Rod specimen of base material

Fig. 3 Housing specimens of Base material

After welding these joint samples were used for a weld strength test, Weld strength tests were carried out by a Universal testing machine using prepared specimens.

Fig. 4 Specimens after Welding used for testing

Fig. 5 Stablizer Link Assembly

Test specimen preparation for Degreased Specimens:

The material (AISI 1018) is degreased with same dimensions which were then prepared for welding. After making a projection of 0.6mm on the rod specimen's, this projected rod is dip into the chemical solution and took out and extra solution is wiped out. After this the specimens took for welding. After welding, these new welded samples go for testing.

Experimental set up

As the process of projection welding has been described earlier. The welding of rod and housing has been done with the various parameters. While welding there are 25 rods and 50 housing specimens were welding of this unprocessed material.

Projection Welding Process Parameters for unprocessed AISI 1018 Specimen

There were various processing parameters that can affect the response in output. These parameters are fixed for all specimens while welding. These are explained as follows

1. Air Pressure 4-6 kg/cm^2
2. Clamping pressure-4.5-5 kg/cm^2
3. Hydraulic Pressure-80-85 kg/cm^2
4. **Squeeze time.** The electrodes come together and the parts to be joined are compressed between the electrodes for 51 seconds.
5. **Weld time.** In this period, the weld current is applied, the metals are being heated enough to melt and fuse together to form what is called a weld nugget. Weld cycle and Current cycle is shown in table as follows
6. **Hold time.** The weld current is ceased but the electrode force is still applied. During this period, the weld nugget cools and the metals are forged under the force of the electrodes for 32 seconds

Table 3: Projection Welding Machine Parameters. For Specimen AISI 1018

Weld Cycle(Seconds)		Current Cycle(Ampere)	
Cycle 1	7.5 second	Cycle 1	0.21 Ampere
Cycle 2	13.7 second	Cycle 2	0.22 Ampere
Cycle 3	24.6 second	Cycle 3	0.21 Ampere

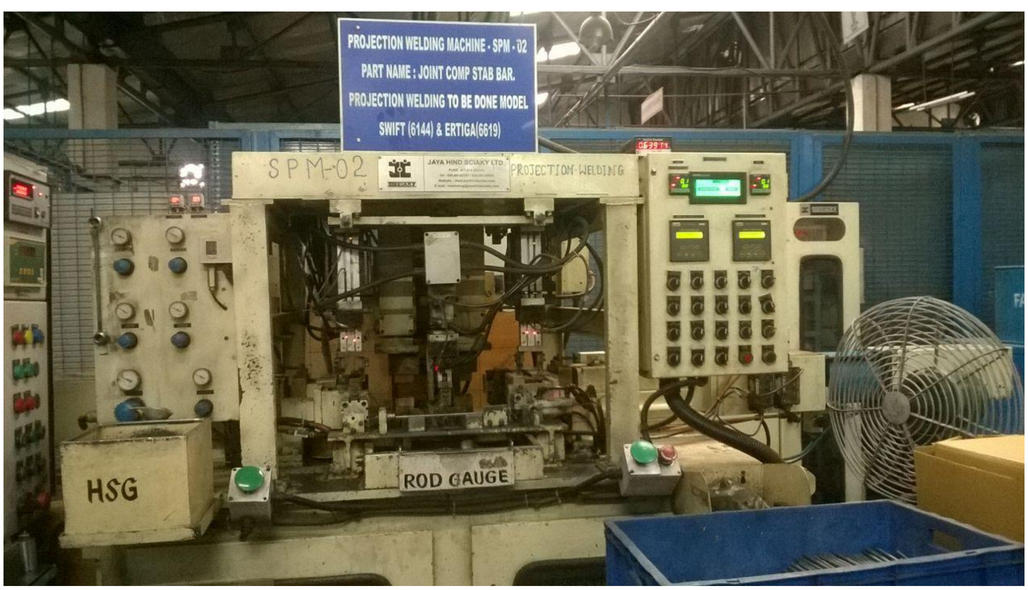

Figure 6: Projection Welding Machine

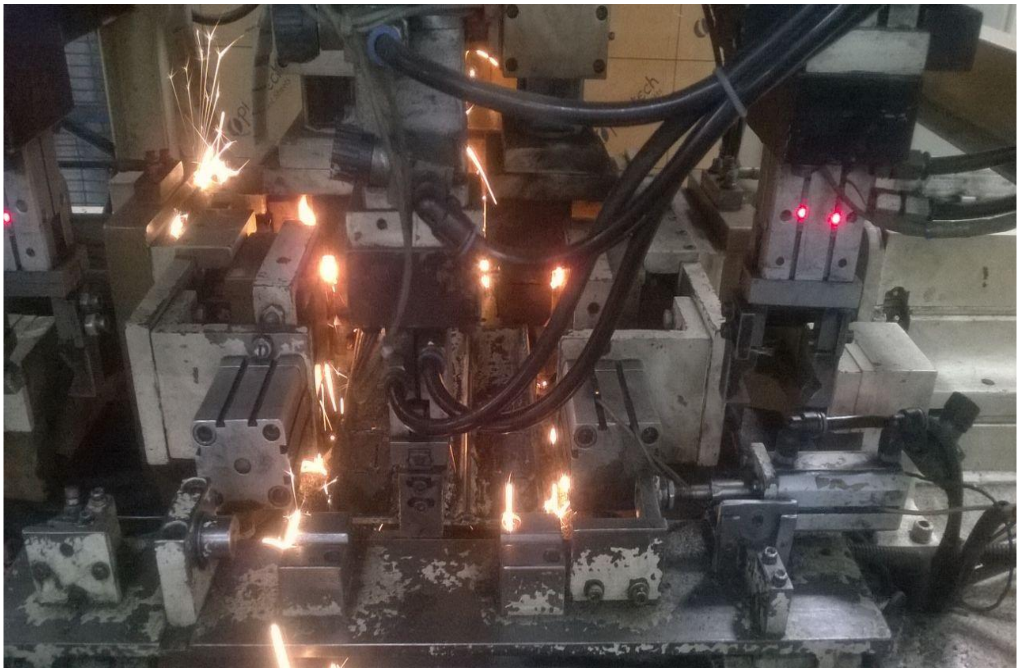

Figure 7: Process of Welding.

Projection Welding Process Parameters for Degreased AISI 1018 Specimen

There were various processing parameters that can affect the response in output. These parameters are fixed for all processed specimens while welding. There is a small change in weld time parameters. These are explained as follows.

1. Air Pressure 4-6 kg/cm^2
2. Clamping pressure-4.5-5 kg/cm^2
3. Hydraulic Pressure-80-85 kg/cm^2
4. **Squeeze time.** The electrodes come together and the parts to be joined are compressed between the electrodes for 51 seconds.
5. **Weld time.** In this period, the weld current is applied, the metals are being heated enough to melt and fuse together to form what is called a weld nugget. Weld cycle and Current cycle is shown in table as follows
6. **Hold time.** The weld current is ceased but the electrode force is still applied. During this period, the weld nugget cools and the metals are forged under the force of the electrodes for 31 seconds

Table 4. Projection Welding Machine Parameters. For Specimen AISI 1018

Weld Cycle(Seconds)		Current Cycle(Ampere)	
Cycle 1	7.5 second	Cycle 1	0.22 Ampere
Cycle 2	14 second	Cycle 2	0.22 Ampere
Cycle 3	27 second	Cycle 3	0.24 Ampere

TESTING OF UNPROCESSED AND DEGREASED SPECIMENS

Testing of Unprocessed Specimens (AISI 1018)

The total numbers of runs for this strength work were 25 in which 05 specimen were used for checking weld strength on Universal Testing Machine rest all 20 specimens are used to check the tensile, yield and fatigue strength of the specimens after weld on a special purpose machine known as Multi Purpose Test Rig machine. .

Figure 8: Sample set up in UTM Machine

Figure 9: Sample set up in MPTR Machine

In the below table Weld, tensile, Yield Strength of all the specimens are as follows

Table 5

Specimen No	Weld Strength (KN)	Specimen No	Tensile Strength (KN)	Specimen No	Yield Strength (KN)	Specimen No	Fatigue Strength (KN)
1	5.0	1	3	1	2.5	1	3.9
2	4.9	2	2.9	2	2.4	2	4
3	4.8	3	2.8	3	2.6	3	4
4	4.9	4	3	4	2.4	4	4
5	4.9	5	3	5	2.5	5	3.9

Testing of Processed Specimens (AISI 1018)

The total numbers of runs for this strength work were 25 in which 05 specimen were used for checking weld strength on Universal Testing Machine rest all 20 specimens are used to check the tensile, yield and fatigue strength of the specimens after weld on a special purpose machine known as Multi Purpose Test Rig machine. .

In the below table Weld, tensile, Yield Strength of all the specimens are as follows

Table 6

Specimen No	Weld Strength (KN)	Specimen No	Tensile Strength (KN)	Specimen No	Yield Strength (KN)	Specimen No	Fatigue Strength (KN)
1	5.4	1	3.3	1	3.2	1	4.2
2	5.3	2	3.2	2	3.4	2	4.2
3	5.2	3	3.3	3	3.3	3	4.1
4	5.5	4	3.4	4	3.3	4	4.3
5	5.6	5	3.3	5	3.3	5	4.2

RESPONSE MODEL GRAPHS

The effect of the all selected input variable processes of unprocessed and derusted the output parameter or response of Tensile, Yield, Fatigue and Weld strength of the materials were found and shown by the model graphs. A response surface graph shows the effect of individual input process on selected response. The effect of following factor graphs in Figures were studied on output.

a) Weld Strength Test
b) Tensile Strength Test
c) Yield Strength Test
d) Fatigue Strength Test

On the basis of experimentations following graphs have been drawn and all these graphs are Column Graphs as shown below

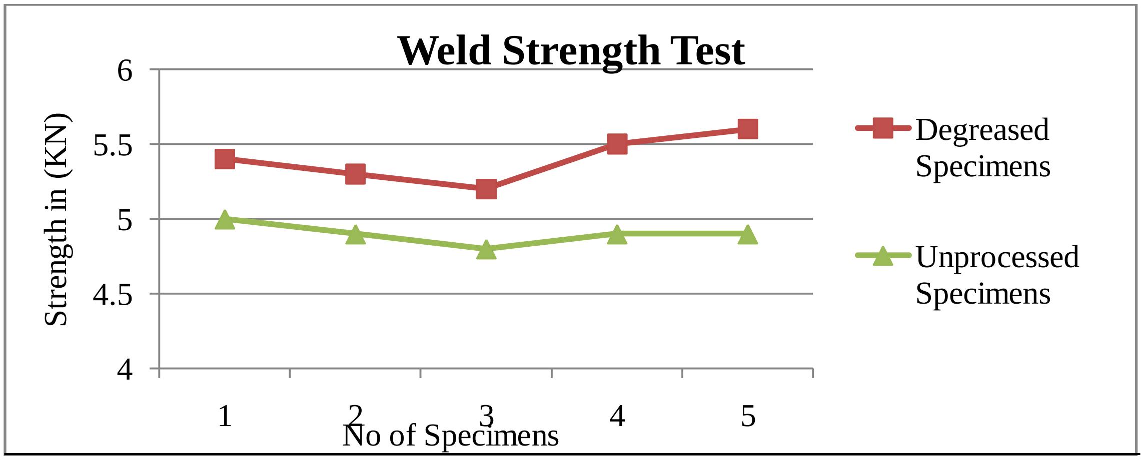

Fig. 10

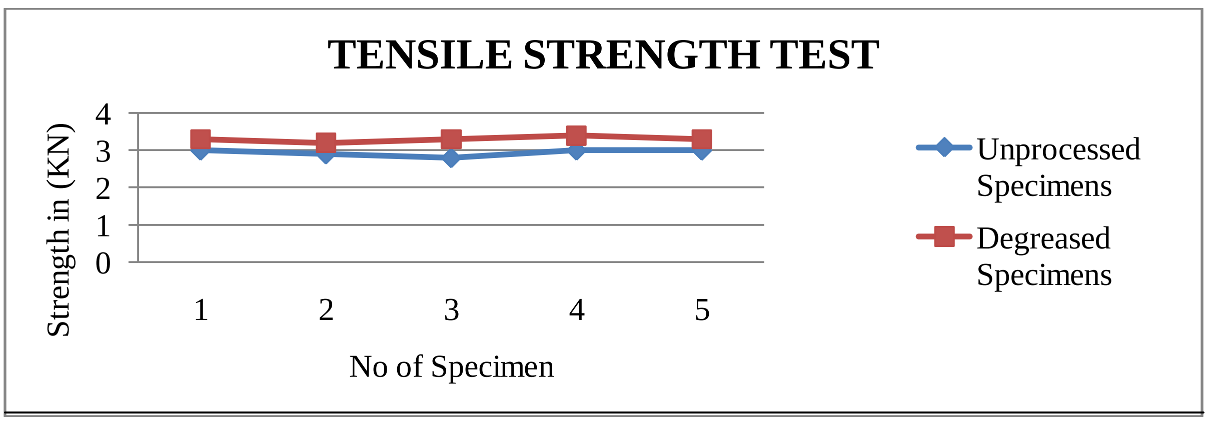

Fig. 11

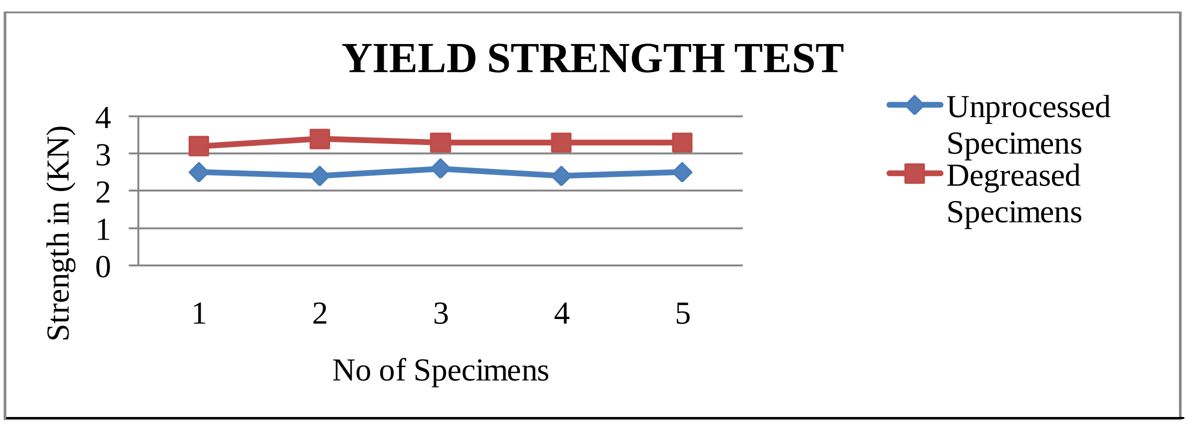

Fig.12

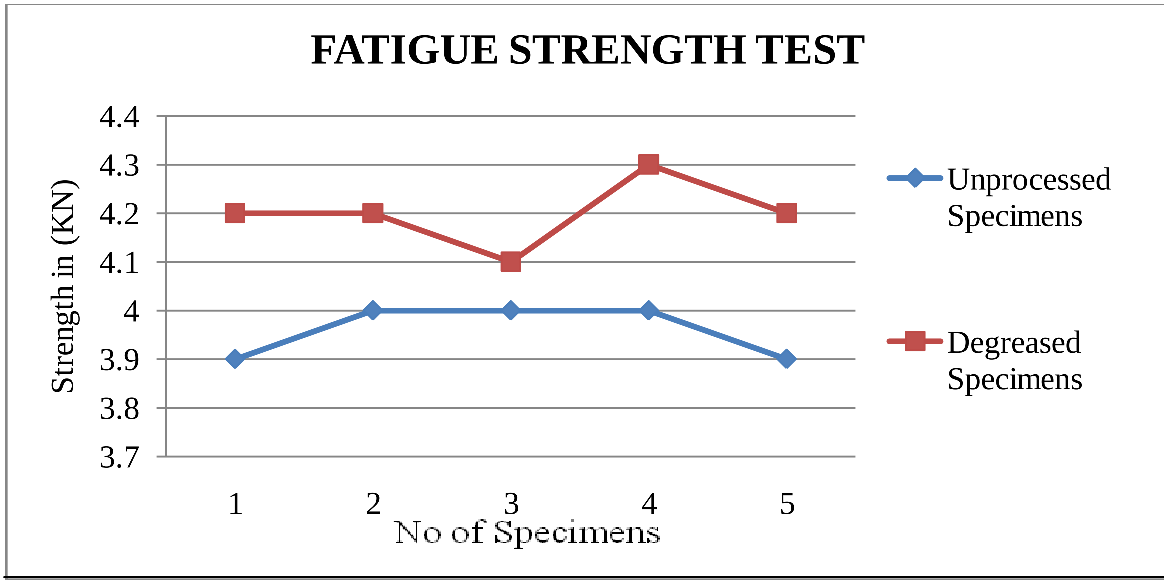

Fig. 13

CONCLUSION

In this paper we have studied the main parameters used in Projection Welding on AISI 1018 material and they are compared with degreased specimens . Here the research found that degreased material gives satisfactory more result as compared to unprocessed material. The tensile, yield, Fatigue strength has found more results than the unprocessed specimen's. This paper shows effectiveness of AISI 1018 material when it is degreased, on this rod specimens. Degreased Welding joint can replace the simple unprocessed specimens due to its satisfactory results. Use of this degreased material specimens can becomes an effective technique to enhance performance of the automobile sectors where more weld joint values are needed.

This study came from the need to better understand the technique of degrease the specimen and then applied to the resistance projection welding control, and in this particular study applied to the welding of the stabilizer link assembly used in auto bodies, a type of inspection not so common in these parts.

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